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Energy Procedia 4 (2011) 5710–5714

**Energy
Procedia**www.elsevier.com/locate/procedia

GHGT-10

Comparative assessment of CCS with other technologies mitigating climate change

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Abstract

The purpose of this report is to show the importance of CCS as a climate change mitigation technology by comparing it with other climate change mitigation technologies currently being developed. In order to objectively evaluate those technologies including CCS currently being researched and developed, the study conducted and compared these technologies in term of their potential in reducing GHG emissions at two set points in the future. The authors believe that the result of the study can be an effective way to promote public acceptance (PA) of CCS technology. The study was conducted with support from the ‘R&D project of CO₂ Geological Storage Technology’ which is subsidized by Japan’s METI. In the result of evaluation, it shows that in order for the CCS technology to become practical, risks must be more clearly identified and the economic viability must be improved. Therefore, preparing frameworks and building social systems that support CCS technology would be inferred to become critical elements. These analysis results can be re-assessed when situations change for each subject technology whenever appropriate and will help make it possible to deal with changing reality in a flexible manner.

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Keywords: climate change mitigation technology ; potential in reducing GHG emissions; comparison of mitigation technology; public acceptance; social systems

1. Introduction

This study compares the GHG mitigation potential value of CCS to other climate change mitigation technologies at two future points in time, 2015 and 2030.

Then just CCS technology was analyzed and the result of its high evaluation in this study was verified.

A statistical analysis of major GHG mitigation technologies was conducted then a value of estimated R&D improvements over the next 5 to 10 years was applied. Technologies relating to nuclear power generation and the absorption of CO₂ from the atmosphere were excluded from the study.

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2. Evaluating aspects of R&D technologies

Each of the technologies selected for the study were evaluated using the following 7 aspects, estimated at two future points in time, 2015 and 2030:

- (1) Estimated GHG reduction potential based on the respective base unit in the grading scale of 1 to 5; ① less than 5% reduction, ② 5~20%, ③ 20~50%, ④ over 50%, ⑤ unknown.
- (2) Total GHG reduction potential in fixed figures or on a scale of 1 to 5; ① less than 0.1M CO₂Tpa/yr, ② 0.1~1M CO₂Tpa/yr, ③ 1M CO₂Tpa/yr~10M CO₂Tpa/yr, ④ over 10M CO₂Tpa/yr, ⑤ unknown.
- (3) Maturity; whether the technology in question is mature enough and is ready for the market, and whether there are technical roadblocks not associated with costs.
- (4) Safety and risks; ① Very high risk, ② high risk, ③ low risk, ④ very low risk, ⑤ unknown.
- (5) Economic viability for now and for when the technology is launched compared to other technologies analyzed in the study; ① larger than 500%, ② 200~500%, ③ 100~200%, ④ less than 100%, ⑤ unknown.
- (6) Potential ripple effects for other sectors; whether side benefits other than GHG reduction can be expected.
- (7) Other possible ripple effects supporting technology transfer across borders such as CDM; potential for ripple effects was graded in the scale of 1 to 5.

Representatives from corporations in associated industries (power, steel, heavy electric machinery, electric equipment, etc.) initially identified over 140 technologies that could potentially be analyzed. This field was then narrowed down to 39 technologies which were scored for the purpose of this study.

3. Evaluating methods and results

Two evaluation processes were used for the analysis. One was a combination of two statistical methods, PCA (Principal Component Analysis) and MRA (Multiple Regression Analysis). The other is DEA (Data Envelopment Analysis). DEA is a method that converts multiple inputs and outputs into a single measure of productive efficiency. DEA differs from AHP (Analytic Hierarchy Process) where the components are weighted subjectively by experts.

In the analysis, PCA was applied to 8 criteria - total potential of GHG reduction, maturity of technology, safety and risks of technology, economic viability for now and for when the technology is launched, other possible ripple effects towards technology transfer across borders.

Firstly, a correlative matrix was calculated by using a data group of 142 objective technologies and then their eigenvalues and eigenvectors were calculated.

In this analysis, from a standardization of point of view, which applies to level difference of 8 aspects data, PCA performed using correlative matrix.

Figure3-1 shows the principal component values of the maximum and minimum of the 142 technologies for reference. In the result, it could be understood easily that the gap between social contribution and technology not contributing to GHG mitigation leads to the difference of the total R&D estimated values.

MRA (Multiple Regression Analysis) is a method to estimate the relation between an objective coefficient and others (elaboration coefficient) which affects it based on data. MRA is sometime used for factor analysis from the point of view how and which valuable effected to the result. In this analysis, MRA is regarded as the directive coefficient as 8 items of total potential GHG reduction, maturity of technology, safety and risks of technology, economic viability for now and for when the technology is launched, other possible ripple effects towards technology transfer across borders and regarded objective coefficient as return on R&D and market promotion. The analysis combined linearly PCA and MRA index and then generated a statistical return on R&D and market application.

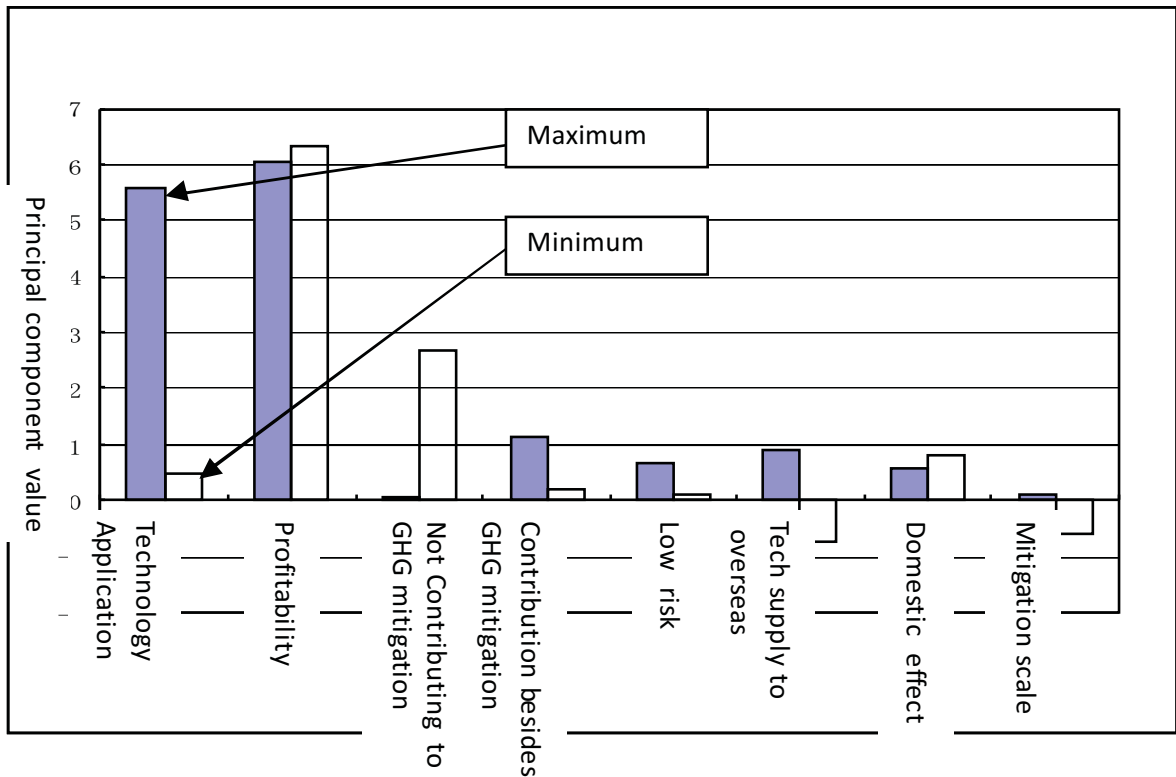


Fig3-1: Principal Component Values

Fig3-2 shows the relation between return on R&D and market application. The area in upper right represents R&D technologies that tend to be supported with a higher level of funding. The CCS technology is placed high in terms of return on R&D, and placed in the median in terms of return on market application. The analysis that combined PCA and MRA generated results that were statistically sound (return on R&D and market application) as the analysis adapted an equation generated from using a principal component as elaboration coefficient to conduct MRA.

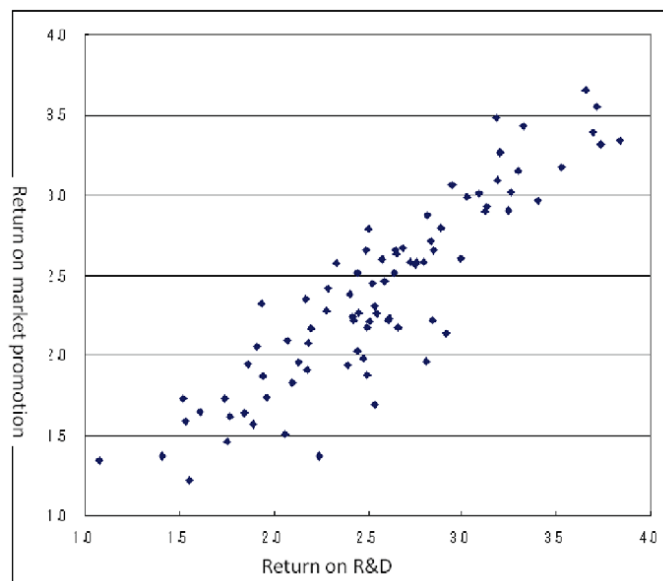


Fig3-2: Evaluating results of whole objectives

Secondly, the DEA method evaluated 39 groups of GHG mitigation technologies by optimization using linear programming with the evaluated weights from (1) Estimated GHG reduction potential based on the respective base unit (2) Total GHG reduction potential (3) Technology maturity (4) Safety and risks (5) Economic viability for now and for when the technology is launched (6) Potential ripple effects for other domestic sectors (7) Other possible ripple effects towards technology transfer across borders such as CDM. Fig3-3 shows both results of principal components and DEA of 39 R&D technology groups.

Results from optimization analysis using DEA showed the characteristic feature of DEA, which is to optimize the evaluation of each technology being considered. Both DEA and principal component results are similar. Principal component results are scattered among high and low levels, whereas the results of evaluation using the DEA method are more polarized. Using the DEA method, CCS technology scored in the 75 percentile range out of 39 technologies.

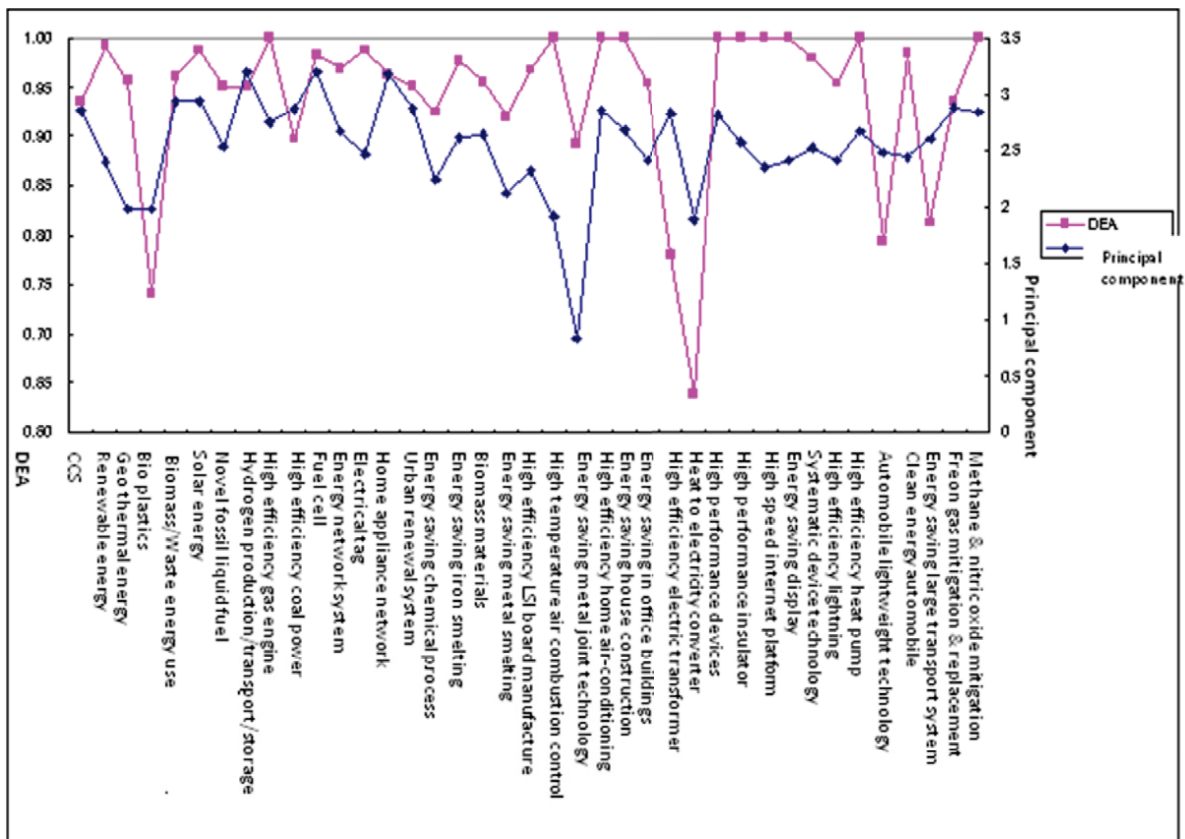


Fig3-3: Comparison of technology groups between DEA and principal component

4. Revaluation of CCS

Table 4-1: CCS evaluated score

	R&D	Ripple effect	Mitigation at 2015	Mitigation at 2030	Mature	Safety & risks	Economic variability	E.V at launched	Domestic effects	Overseas effects
CO ₂ Capture and Storage	2.85	2.64	②	④	③	②	②	③	③	④

In terms of the estimated total potential reduction of emissions, the figure for CCS technology is estimated to be rather low at 1M CO₂tpa/yr for the year 2015 because of the limited number of locations that can be used to store CO₂, though a larger reduction of emissions is expected in the year 2030 at 1M CO₂Tpa when more storage sites have been identified. While the maturity level of the technology is rather high, in that the standard CCS technology has reached the demonstration phase, public acceptance concerns remain over possible adverse effects on humans, flora and fauna and various ecological systems in the case of leakage.

When compared with the conventional technologies that do not have CO₂ capture capabilities, CCS is still economically inferior even when applied at a concentrated emission source because of the energy needed to capture CO₂ (200~500% more in terms of kW). It is projected that the figures will improve by the time the technology is in the proliferation stage. In order for CCS technology to be competitive, some ways of linking CO₂ emissions reduction to economic benefits needs to be devised. CCS technology is directly linked to reducing domestic CO₂ emissions and the expected ripple effect such as capital investment should be large. In addition, there is the possibility that the technology to inject gases underground in the oil and gas producing countries (to store CO₂ in depleted oil and gas fields) will be adopted in the CDM and that some international CCS mechanism will be created. This will make the expected ripple effect of transferring CCS technology globally a reality.

The next two points would improve the (KAIZEN) CCS evaluating score according to above analysis of the CCS results.

- (1) The research of CCS risks will advance and the score on safety and risks will improve from ② to ③
- (2) A domestic CDM system to support CCS and the international adoption of CCS in the CDM plus the high price of CER over the long term in the future will improve the score of economic viability at launch from ③ to ④.

CCS technology ranked 17 out of the 39 subjects after decreasing the risks and improving the economic viability aspects of the technology. These results show that in order for CCS technology to become practical, risks must be more clearly identified and addressed and the economic viability must be improved. However, to improve the economic value of deploying CCS, the escalation of CER and the adoption of domestic CDM systems will be needed. Therefore, preparing frameworks and building social systems that support CCS technology is critical for its success and the research into CCS risks should be accelerated.

References

- 1) Yoshiharu Takamura and Kaoru Tone, A comparative site evaluation study for relocating Japanese government agencies out of Tokyo, *Socio-Economic Planning Sciences* 37(2003), pp85-102